BUILDING UNIVERSITY–SCHOOL PARTNERSHIPS: AN EXERCISE IN COMMUNICATION AND UNDERSTANDING

Michelle Hall-Wallace — CATTS Program, Department of Geosciences, University of Arizona, Tucson, AZ 85721-0077

Nancy L. Regens — CATTS Program, Department of Geosciences, University of Arizona, Tucson, AZ 85721-0077

ABSTRACT

The Collaboration to Advance Teaching Technology and Science (CATTS) is a program to develop sustainable partnerships with Kindergarten through 12th grade level (K-12) educators to improve science, mathematics and technology education at all levels. The partnerships bring together faculty and students at the University of Arizona with teachers and their students from six local school districts. In grades K-6 these partnerships typically work to increase the amount of science inquiry used in the classroom by helping teachers adopt and implement inquiry-based curriculum. In grades 7-12, the program also focuses on increasing the use of inquiry, but often does so through short- and long-term research experiences for students.

CATTS partnerships are effective because they benefit all stakeholders. CATTS creates opportunities for graduate and undergraduate students (the CATTS Fellows) to learn effective teaching practices and to be active participants in K-12 education. School districts and University of Arizona outreach programs benefit when CATTS Fellows work on projects that address identified educational needs in K-12 schools. K-12 teachers and students benefit from the additional classroom assistance and resources provided through the CATTS program.

This paper will focus on the design of our program and the conditions necessary to establish and maintain partnerships that promote inquiry and research in schools. The first two years of the project taught us the importance of communication to foster mutual respect and understanding of our shared goals. A high degree of coordination and sensible logistics are also critical to the success of a complex project such as CATTS. Only after communication and coordination is well established is it possible to engage K-12 teachers and their students in inquiry and research.

Key words: teacher education, graduate education, pre-college education.

INTRODUCTION

One of the most common complaints of university professors in science and engineering is that undergraduate students entering the university are poorly prepared in these subjects. Clearly related to this is the fact that K-12 teachers themselves feel inadequately prepared to teach science to K-12 students, a result of their own limited undergraduate science background and the teaching methods employed by their college professors. In a survey of 1.5 million elementary teachers, only 26% reported feeling qualified to teach science (Worth, 1997). This discomfort in teaching science is also reflected by the average number of minutes per day devoted to teaching science in grades K-6. K-6 teachers report that they spend less than 30 minutes per day teaching science (Weiss, 1997). In an attempt to address both issues, the Collaboration to Advance Teaching Technology and Science (CATTS) provides talented undergraduate and graduate students majoring in science, mathematics and engineering with opportunities to serve as scientific and technical resources in K-12 schools. CATTS' goal is to build strong partnerships between faculty and students at the university and educators in local K-12 school districts that improve science, mathematics, engineering and technology education for students in K-16.

University partnerships with K-12 schools are an important mechanism for implementing the science education reforms that call for increased use of inquiry and involving students in real scientific investigations (National Research Council, 1996; Ahlgren and Rutherford, 1990; Ireton, et al., 1997; National Commission on Mathematics and Science Teaching for the 21st Century, 2000; Barstow and Geary, 2002). They are also an effective mechanism for preparing the future professorate in their role as teachers and giving them the skills and knowledge to collaborate with K-12 schools. Outcomes of CATTS include improved communication and teaching skills for the Fellows, enriched learning experiences for K-12 students through use of inquiry and research experiences, professional development opportunities for K-12 teachers, and strengthened partnerships between the university and local school districts (Hall-Wallace and Regens, 2003). Funding from the NSF Graduate Teaching Fellowship (GK-12) program provides fellowships and training for the graduate and advanced undergraduate students (the CATTS Fellows) to work with the K-12 teachers and students and experience inquiry-based teaching first-hand.

While not a specific goal of CATTS, providing K-12 students with information and opportunities to explore careers in science and technology is another benefit of the partnership. One difficulty in attracting K-12 students to scientific and technical careers is that they rarely experience the excitement and wonder of scientific discovery in their formal education. Consequently, we lose many potential scientists and engineers before middle school (Ahlgren and Rutherford, 1990). In contrast, in a survey of 1700 National Science Teachers

Program and Sponsor	Description
DESERT Project School	Assists with implementation and extensions of K-6 inquiry-based science kits
GLOBE University	Uses technology in hands-on collection of physical, historical and cultural data related to the Tucson environment for long term monitoring by grades 4-12
TOXICOLOGY School & University	Emphasizes environmental science, health issues and science careers using a project-based learning context and incorporating all traditional high school academic subjects
Technology and Math School	Promotes mathematical problem solving using new technology in middle school classrooms
SAGUARO Project University	Uses technology-based Earth science curriculum to promote inquiry and student directed research in high schools
Sahuarita Project School	Conducts long-term monitoring of an endangered species of cacti by middle and high school students
SpiNet University	Fosters use of seismic data and seismometers in high school Earth science and physics classrooms
Ha:san University & School	Integrates math, science and culture in project based learning at a Native American high school
BIOTECH University	Uses biotechnology to conduct investigations and research in high schools
Earth Science School and University	Integrates GIS technology, science and math into the study of Earth in high school
Marine Discovery University	Promotes use of inquiry-based marine science activities for high school students
Learning Tree University	Emphasizes understanding of the complex environment and stimulation of critical and creative thinking in middle school
A Sense of Place School and University	Engages high school students in hands-on, field-based studies to explore the history of volcanism, rivers and arroyos, desert ecosystems, and resource use in Tucson through time

Table 1: Example CATTS Partnerships and Activities.

Association members, 92% of teachers who worked with scientists said it bolstered their motivation and enthusiasm for teaching science; 90% said it increased their understanding of the science content; and 87% said it improved their teaching (MRI, 1999). Data like this gives us confidence that investing in a partnership with K-12 educators will develop students who have a greater interest and literacy in science and technology and who are better prepared to pursue careers in those fields after high school.

PROGRAM ACTIVITIES AND THE ROLE OF THE FELLOWS

CATTS Fellows contribute to many university outreach programs, school district supported professional development programs and school-based initiatives while fulfilling the goals of our program (Table 1). We place 14-28 Fellows each year in a variety of partnership roles. Pairs of Fellows, one graduate and one undergraduate student, are assigned to each project. These projects and the corresponding role of the Fellows fall into three general categories, although there is much overlap among them. Fellows can serve as a:

(1) Resource agent implementing an existing university outreach program. In this model, university outreach programs submit a proposal outlining activities that a Fellow will conduct for their program. For example, many of our outreach programs offer professional development workshops or graduate-level courses that introduce teachers to new curriculum materials or long-term,

student-directed research projects. A Fellow assigned to this type of project assists with teaching the professional development workshops and provides the added bonus of helping teachers when they implement the new curriculum in their classrooms.

The Saguaro Project (http://saguaro.geo.arizona.edu) is an example of this type of partnership. University scientists and educators have developed an inquiry-based Earth science curriculum that uses a Geographic Information System. With the assistance of two CATTS Fellows, 10 of the 22 high schools in our region have now implemented the curriculum in the past two years with only 1-2 days of formal training. In previous attempts to help teachers implement the new curriculum, less than 25% of the teachers were successful after attending a three-week professional development workshop. Obstacles included difficulty getting the software installed on school computers and anxiety about teaching the new curriculum without additional assistance in the classroom. Having the Fellow work with school technology staff to install and test the software, assist the teacher with classroom implementation, and even conduct more focused one-day workshops for teachers solved these problems.

In two schools, this program spawned student research projects. In one case, the students had completed a GIS module on water resources and then worked with the Fellow in her research area to study the water quality in one of the last riparian areas in Arizona. In the second case, the students used their newly developed GIS skills to conduct an environmental assessment of a dry wash in their neighborhood. The wash was filled with trash and off-road driving had destroyed most of the natural vegetation. The students used historic photos and maps to understand the changes that have occurred over time in the area, developed a restoration plan using the GIS, then held a community forum to discuss their plan and gain approval before implementing it this year.

(2) Resource agent directly connected with the professional development program of a local school district. This model is similar to the one above except that the district proposes and supervises the Fellows' activities. Fellows work with master teachers to conduct professional development workshops that train classroom teachers to implement newly adopted inquiry-based curriculum units. By modeling scientific thinking and investigations, Fellows help teachers become comfortable with the inquiry process and the content in the unit, while the master teacher provides teaching ideas and classroom management tips (Hall-Wallace and Regens, 2003). A Fellow might also provide follow-up assistance by working directly with teachers to implement the curriculum in their classroom.

This model is in use in Tucson's largest school district, which is making district-wide, systemic changes in the elementary level science curriculum as part of an NSF funded project (http://instech.tusd.k12.az.us/~desert/desert.html). The majority of teachers in elementary school are uncomfortable teaching science and mathematics (NSTA, 2002). This discomfort, combined with the emphasis on developing students' reading and writing in grades K-6, results in few teachers offering a high quality science learning experience for their students. The Fellows working on this project spent six to eight weeks in a school working with three to four teachers at one grade level. They assisted them in all aspects of teaching these new inquiry modules. They also led weekly workshops after school to help teachers become comfortable with the upcoming week's lessons. The district observed that teachers working with the Fellows were more likely to implement the new curriculum and often had a change of attitude towards science (G. Paulin, personal communication, 2001). A second grade teacher conveyed the following in a survey (Hall-Wallace and Regens, 2003):

> "My Fellow helped me see the importance of teaching science. I have been so focused over the past 10 years on teaching reading and writing that everything else has been secondary." — Mrs. S., a second grade teacher.

Mrs. S was not the only one to change. The Fellow relayed the following about her experiences.

> "I came in early in the semester planning to measure Manduca larva with the students. Mrs. S pointed out that second graders don't know how to measure with rulers. I was speechless for a moment, as I had not really thought of that. I recovered quickly and suggested that we use paper clips to measure and give children an idea of units. Instead, Mrs. S taught a small lesson on how to measure. She was able to anticipate what mistakes the children might make, like not starting at the end of the ruler, or starting at the wrong end of the ruler. The children picked it up quickly and it amazed me! After that I realized that I had a great deal to learn about teaching and Mrs. S and I started planning almost every lesson together." — A CATTS Fellow

Fellows have been successful in introducing research experiences that extend the district curriculum. For example, two elementary schools created gardens that the students are actively involve in planting, nurturing, and harvesting. The gardens provide many opportunities for studying plant growth and plant-insect relationships.

(3) CATTS Fellow in Residence at a local school. In this role a Fellow works with teachers in a school to enrich the science program at one or many grade levels. The school must work as a unit to identify ways that integrate the Fellow into their classrooms and curriculum before the Fellow arrives on campus. This process ensures that both the Fellow and K-12 teachers have similar goals

Figure 1. Students participate in long-term research on endangered cactus species with the help of a CATTS Fellow.

and expectations for the experience. A Fellow might help a teacher with a specific curriculum unit, provide professional development opportunities to advance groups of teachers' content knowledge in different areas, or work with small groups of students or the entire class conducting a long-term research project. The Fellow could be assigned to one school for a year or rotate among several schools during the school year depending on the needs of the school and projects involved. A similar model has been quite successful for scientists working with schools in England (Natynczuk, 1991).

This type of partnership is one of the most exciting and challenging assignments. The variety of activities a Fellow might engage in during the year is either large or very small. Fellows in Residence have been used to design and implement a long-term monitoring study for an endangered cactus on one middle school campus (Figure 1). Students gathered the data and wrote a report that the school district submitted to the Arizona Game and Fish department. This model has also been used to develop an entirely new course in Earth science at a local high school. In that case, the Fellow worked closely with the teacher to gather new and innovative resources for the course during the summer months including a seismometer and weather station. During the school year, the teacher and Fellow shared teaching responsibilities based on their individual expertise. Students engaged in a yearlong monitoring of local seismicity and developed catalogs of seismic events that could be correlated with local mine blasts, construction, and weather disturbances. This monitoring project continues this year although the Fellow is not working in the school.

Most of our partnerships are focused on introducing new content materials (often related to new scientific tools or discoveries) into the classroom and helping teachers teach science more effectively. The instructional materials the Fellows implement must be aligned with the local and/or national education standards and be appropriate for the target audience to get buy-in from the teachers and schools. Development of high quality classroom resources requires knowledge and expertise in teaching and learning that the Fellows generally do not possess. Thus, we discouraged Fellows from engaging in curriculum development and encouraged them to find existing high quality resources that fill the need.

DEVELOPING THE PARTNERSHIP PLAN

A healthy and productive partnership relies on respect for, and understanding of, the needs, background and interests of all stakeholders involved (Sussman, 1993). In our case that includes the Fellows and their faculty mentors as well as K-12 educators and administrators. Common barriers to effective university - K-12 partnerships include a lack of understanding of the different cultural or institutional norms of the communities involved (Gomez et al., 1990). Another potential barrier that can result in unreasonable expectations and disappointment is a lack of communication among all stakeholders about the needs and roles of different partners.

In developing the concept for CATTS, we met with teachers, administrators and superintendents from local school districts to design a partnership to meet their needs. In addition, we involved university graduate students and faculty directing outreach programs in discussions about how a CATTS partnership might enhance their efforts. Our partnership plan incorporates the many ideas generated by these groups and reflects the community buy-in, which is an important part of our ongoing success. The two most important design elements are providing multiple mechanisms for communication among all stakeholders and allowing flexibility in our program. Communication with Fellows, faculty mentors and partnering teachers through focused discussions in our classes, monthly journal writings, and program and partnership evaluation surveys allowed us to identify barriers early (Hall-Wallace and Regens, 2003). Flexibility in our program allowed us to respond quickly with training or other mechanisms to help the Fellows and partners overcome these barriers.

University Barriers - Universities long ago recognized that partnerships with K-12 schools in the areas of preparing teachers, recruiting a diverse student population, and stimulating interest in high demand careers are important. However, most universities are still reluctant to provide the faculty with the incentives and rewards that allow these partnerships to blossom. Until changes in the attitudes of faculty are made, progress will be slow. Some faculty, but not all, are broadening their own roles and are more willing to allow their graduate students to engage in activities such as outreach. However, the climate of graduate school still emphasizes research over teaching. Because of this, it is important to ensure that the graduate Fellow has his/her mentor's approval to participate in programs like CATTS (Alper, 1994; Hall-Wallace, 2000). We work with faculty mentors to help them see the value of CATTS to their

students and society in general. We also provide opportunities for the faculty to participate in relevant teaching workshops and social activities associated with CATTS. With the faculty mentor's support, CATTS Fellows are able to embrace and contribute to the university's education and outreach mission. Hopefully this experience will help our Fellows make cultural changes when they become faculty members at other institutions or work in industry.

While their intent is good, many university outreach programs have failed at building partnerships and effecting change in schools due to a lack of understanding of the K-12 culture and environment (Sussman, 1993; Gomez et. al., 1990). The CATTS program fosters a two-way relationship in which university Fellows and faculty mentors can increase their understanding of K-12 education while K-12 teachers come to understand the challenges of scientific research and the university environment. This cross-cultural understanding is fostered in our spring preparation workshop through panel discussions with K-12 teachers and college faculty. We also have K-12 teachers demonstrate the richness of inquiry teaching in several workshop sessions. This allows the Fellows, university faculty and K-12 teachers to work side-by-side solving complex problems with inquiry thus, learning new ways to teach. Finally, we host a panel of Fellows who have completed their fellowship to talk about what they learned and accomplished in their CATTS experience and what it meant to them. The audience includes faculty mentors and K-12 teachers in the CATTS program. This completes the communication loop, allowing everyone to discuss and reflect on the impact of university – K-12 partnerships. Reported impacts of these partnerships include helping the current and future professorate be more effective in inquiry-based teaching techniques. These faculty will, in turn, prepare future K-12 teachers to create learning environments where inquiry and problem solving is the norm. If successful, we will have changed the science teaching pedagogical cultures of both university and K-12 institutions.

K-12 Barriers - Teachers have busy lives and at first glance, working with a Fellow and changing their curriculum does not always seem like a benefit. Any disruption of a teacher's very full schedule, even when someone is trying to help, can be stressful. Overcoming this barrier requires showing teachers how the partnership will free up more time than it consumes or how it will improve the quality and impact of their teaching without increasing the time commitment. Another form of resistance often arises out of the stated premise that the CATTS program will help improve science education in schools. For teachers under fire for every failing in today's schools, this premise can contribute to mistrust of the Fellow. Teachers may see the Fellows as someone who may judge them harshly for their lack of science or mathematics knowledge, for example.

We break down these barriers by clearly defining the role of the Fellows and the teachers in CATTS and by providing several incentives for the teachers in addition to having the help of the Fellow. When the teacher is clearly acknowledged as the classroom expert and the Fellow as the technical expert, the partnership works best. In addition, we counsel our Fellows to resist the role of being a teacher and fountain of knowledge. Rather, we teach them to fill a support role and to work in the background to help the teacher become more effective. Fellows may use their time and resources to find new and engaging classroom activities, test them out and help the teacher plan how to use them. For example, a Fellow working with a master teacher in a local marine biology class developed a learning activity called the Great Plankton Race. One result of this activity was a note from the teacher, who said: "Working with J. has been an incredible experience for me and my students. Are you sure there's not a way we can have the program again next year?" (K. Krucker, personal communication, 2001). Initiating a partnership with these well-defined roles has been effective in earning the trust and respect of the teacher. Over time, the teacher becomes comfortable working with the Fellow and willing to team teach or even let the Fellow teach independently for short periods of time. This type of partnership also combats the notion that scientists only come to the classroom to make a presentation and leave. Keeping teachers in control of their classrooms and providing them with opportunities to learn about new science and science curriculum helps build their confidence in teaching science (Gomez et. al., 1990; Sussman, 1993). This is also true when Fellows aid in implementing new software or educational technology. One of our Fellows has been teaching Excel to middle school teachers and students. She worked with one teacher who was anxious using computers; even reading email was an uncomfortable task. After working together for a year, the teacher is now enrolled in a graduate program in educational technology (C. Hammond, personal communication, 2001).

Benefits to the teacher extend beyond help in their classroom. All programs in CATTS include professional development experiences for the teachers that range from workshops lasting a few hours to several weeks. In addition, all teachers who work with the Fellows on projects or curriculum outside of school hours are eligible to earn professional development credit. These credits can be applied to renewal of a teaching certificate or towards pay increases. We also provide teachers working with CATTS Fellows the opportunity to purchase up to $750 in supplies for their classroom. These resources encourage the teacher and Fellow to pursue new and innovative projects in the classroom. We have purchased everything from plants, shovels and gloves for a garden project to digital video and a DVD player for a classroom. To help teachers understand the breadth of CATTS' projects and make them feel part of the larger CATTS community, we include them in social gatherings during the year. Finally, we recognize the teachers with a certificate signed by their Principal, the school district Superintendent, the Dean of the College of Science at the University of Arizona, and the Project Director.

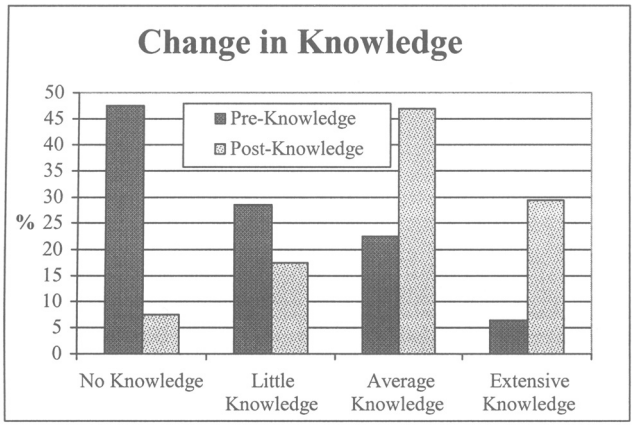

Figure 2. Fellows report a significant increase in knowledge about educational issues and concepts as a result of the preparation workshop.

SELECTION AND PREPARATION OF FELLOWS

The CATTS program works on an 18-month cycle in response to the university and K-12 school schedules. In the fall semester, we solicit project ideas from local teachers, schools and school districts, and university outreach programs. After identifying projects suitable for our program, we advertise them widely across the university campus to recruit potential Fellows from science, mathematics, engineering and technology degree programs. We do not recruit students in education programs because the purpose of the program is to make future technical professionals aware of their potential role in outreach. Email lists, presentations in classes and advertisements in the school newspaper are our primary recruiting mechanisms. Many of our projects serve high minority schools; we specifically target under-represented groups and multi-lingual students in our recruitment. This has resulted in more than 25% minorities in our program, which is well above the minority representation in the sciences and engineering disciplines across our campus. Interested students apply for a fellowship and must indicate one or more projects that they would like to carryout. Before the end of the fall semester, we select the Fellows and assign them to a project based on their applications, letters of recommendation and interviews.

Recipients of the fellowship must complete a preparation workshop during the spring semester. They begin their fellowship and associated work in the schools during the summer. Fellows work 10 hours per week in the schools and 5 hours per week on preparation throughout the fellowship year. In exchange, the graduate Fellows receive $21,000 in stipends as well as other benefits while undergraduate Fellows receive $10,000 in support.

The spring semester (2 credit / 30 contact hours) preparation workshop is designed to help the Fellows construct their understanding of the K-12 school environment, student competencies, the content-related needs of their teacher partners and effective methods for meeting some of those needs. Fellows learn how to be a resource to facilitate high quality instruction in the classroom. The basic format of the workshop is a series of topical sessions that build an understanding of effective teaching methods. Through readings, discussions, guest speakers and inquiry-based activities, the Fellows develop an understanding of:

- their role in the schools;
- state and national science education standards, mandatory testing and other programs;
- communicating sophisticated scientific ideas in simple terms;
- methods of inquiry-based instruction;
- methods for teaching diverse learners;
- questioning techniques and assessment strategies;
- sources of resource materials and other classroom support; and
- classroom management and general school district policies and procedures.

The inquiry-based activities used in the workshop are from the University of Arizona's outreach programs or from local school districts' mandated core curriculum (e.g., FOSS kit-based science program). Along with experiencing inquiry first-hand, Fellows learn to evaluate curriculum for effectiveness in meeting state and national standards and its ability to address learners with diverse learning styles. Interactions with K-12 teachers during the workshop and through classroom observations provide Fellows with opportunities to initiate their partnerships. We rely on significant help from classroom teachers in this preparation workshop. Teachers conduct inquiry investigations, share their experiences through panel discussions and generally make themselves available to our students. The Fellows consistently rate the interactions with the teachers in this workshop as the most valuable activity in helping them understand the school/classroom community.

Fellows learn to communicate scientific and mathematical concepts by applying the concepts taught in the topical sessions. They begin by developing a five-minute presentation on their research or field of study that is appropriate for a general audience. K-12 classroom observations and teaching activities expand in length and depth over the semester. Initially, the Fellows must visit three classrooms to observe teachers using inquiry. Typically we assign them to visit classrooms where current Fellows are working. After completing the observations, they must develop three lesson plans and teach them in the classroom. They work with current Fellows to determine appropriate topics for lessons and team-teach them with the current Fellows and their partner teacher. Fellows must emphasize different teaching methods or skills in each experience. Surveys of the Fellows indicate that 76% begin the semester with little knowledge or awareness of the core concepts and ideas in science education. By the end of the semester, 76% of the Fellow's reported that they had an average to exceptional knowledge of these concepts and ideas

(Figure 2). This suggests that our preparation workshop is providing a broad foundation for their growth as science educators.

Faculty mentors and K-12 teachers working with the Fellows are encouraged to participate in three workshop sessions of their choice. The K-12 teachers receive professional development credit from their school district for their participation and an honorarium from the CATTS program. Faculty mentors have the opportunity to learn more about teaching and their student's activities. In addition, the preparation workshop offers an effective means for faculty mentors, Fellows and K-12 educators to become more knowledgeable about current outreach programs and to share expertise that could improve those programs. Unfortunately, only a few faculty and teachers have participated in this activity. To keep these groups better informed of the Fellow's activities and the impact of the program, we have instituted a new end-of-year panel during which Fellows finishing their fellowship discuss the impact of the experience on them, and the teachers and students they served. All faculty mentors are strongly encouraged to attend.

During the fall semester after the Fellows begin working in schools, they attend a weekly one-credit (15 hours) seminar that helps them resolve obstacles to building a successful partnership. Fellows share experiences among themselves to improve their skills in outreach and education. This seminar provides critical support needed to keep the Fellows from feeling isolated in their outreach work. Discussions, presentations by teachers and readings are incorporated into the seminar to address particular needs that arise. During the second semester of the fellowship, the current Fellows are asked to occasionally participate in the preparation workshop for the following year's Fellows.

PROJECT MANAGEMENT

Project management is done on three levels. An advisory board consisting of the equal representation from the K-12 and university communities provides guidance to the Program Director (Hall-Wallace) and the Program Coordinator (Regens) in the areas of recruitment and selection of projects and Fellows, budgets and community participation. The Program Director oversees the budgets and assessment, and provides direct oversight of the project. She also teaches or co-teaches the preparation workshop and seminar with another faculty member or the Program Coordinator.

The Program Coordinator is responsible for the majority of the day-to-day activities. This includes recruitment of projects and Fellows, monitoring Fellows and assisting them with problem solving, communicating with school principals, classroom teachers and faculty mentors about the program, and many other tasks. To simplify supervision of the large number of Fellows, we require them to submit a weekly log that describes the work they completed in the previous week. We encourage the Fellows to also include any questions they have about their fellowship and to make requests for help if needed. These weekly reports are very useful to us in heading off potential problems in the classrooms.

The Program Coordinator's role is to anticipate opportunities and obstacles that the Fellow may encounter and prepare them for events that might come up. When working in the schools, the Fellows are required to submit their work schedules for the upcoming week. The schedules allow the Program Coordinator to visit them frequently in the classroom without the need for pre-arrangements. This also gives Fellows an opportunity to invite us to attend some of the more fun and engaging activities taking place in their classrooms. To make it as easy for our Fellows to submit the information, we created interactive forms on our web site (http://www.geo.arizona.edu/catts/).

SUSTAINING THE PROGRAM

Sustainability is directly related to the ability of the program to serve a critical need and to serve it well. We have been evaluating our progress nearly continuously using both formative and summative assessments gathered through journal writings, interviews, and surveys of Fellows and partner teachers. Each of these assessments provided ideas for small adjustments to the program that have improved it significantly. Participating K-12 teachers were surveyed about how they felt the partnership had proceeded and how we could improve our program. More than 80% of the 32 teachers' participating in CATTS during our first year reported increases in their use of inquiry and the amount of science they teach in their classroom (Hall-Wallace and Regens, 2003). These same teachers indicated that they would continue to use inquiry and the new curriculum after the Fellows had left. This suggests that the one-year partnership will have a lasting impact on many students in the future. Based on the results we have to date, we are confident that our program is addressing a real need at the university and in local schools.

Sustainability of the program will require changing the reward system for graduate and undergraduate students to participate in this effort. Currently the NSF funding provides nearly $500,000 each year in fellowships, but this is only temporary. Our plan is to tie the CATTS program to a new program on our campus to prepare our graduate students for higher education teaching. The university has just approved a 10-credit graduate certificate in higher education teaching. The certificate program requires six units of course work on teaching strategies and four units of practicum in which the graduate student teaches a course or laboratory under the supervision of a team of faculty interested in improving teaching pedagogy. Using this model, we are working with the university to allow the course work and field experiences provided through CATTS to apply to the certificate requirements. Alternatively, we are also exploring developing a new certificate in K-12 outreach for graduate and undergraduate students who complete the CATTS program. In addition to the course work

required, we would add an additional course on designing outreach programs and partnerships.

CONCLUSIONS

The gap is growing between the number of scientists and engineers needed in our society today and the number currently available (National Commission on Mathematics and Science Teaching for the 21st Century, 2000). The heightened demands of our new global economy and the advanced technology need to function in our society have widened this gap even further. It has become apparent that current educators in our K-12 schools are not well equipped to prepare future generations of students for careers in these fields. To meet these challenges, partnerships between K-12 schools, colleges and universities are needed and encouraged. These partnerships require open lines of communication and must acknowledge and respond to differences in cultures and responsibilities among all stakeholders. They must also provide incentives and rewards for K-16 educators to participate. The result can be a significant improvement in science inquiry in K-12 schools.

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